

# NASA TECH BRIEF

## NASA Pasadena Office



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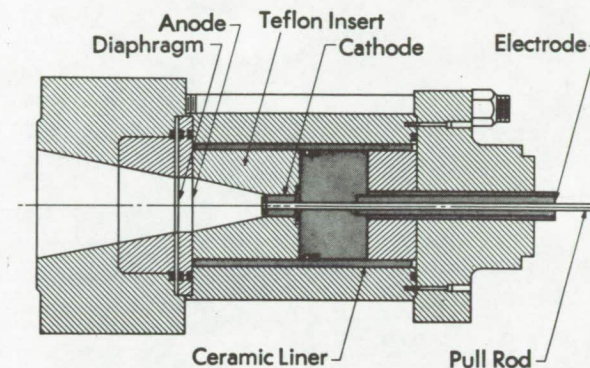
### Improved High-Performance Shock Tube

Electric-arc-driven shock tubes of the types available prior to this time have seldom been capable of producing shock velocities in excess of 15 km/sec. Typically, such facilities use a 100-capacitor bank (each 14.5  $\mu\text{f}$ ) rated at 290,000 joules when charged to 20,000 volts. However, shock velocities of 25 to 48 km/sec were required for the study of problems concerning entry into the atmospheres of Jupiter and Saturn. Since other electric-arc-driven shock tubes have been constructed with capacitor storage systems of 1 million joules without substantial increases in velocity, it was obvious that further increases in energy storage capacity would be fruitless and that a new design approach would have to be developed to obtain higher performance by improving the efficiency of converting electrical energy to flow energy.

A major improvement was made by substituting Mylar diaphragms for steel diaphragms. Steel diaphragms have several disadvantages that contribute to energy losses. Other improvements included (1) better electrode design (polarity, materials, and configuration), (2) improved flow by opening the throat and removing all constrictions, such as ignition devices, and (3) improved driver geometry by optimizing volume and shape.

The basic dimensions of the driver tube which was used in conjunction with a 290,000-joule storage facility were maintained, that is, 15.2-cm diameter and variable length. The configuration for the improved driver is shown in the diagram. The cathode is a 3.2-cm diameter cylinder made of a sintered tungsten alloy. A hole in the cathode tip permits the trigger wire to be pulled through. The anode is a copper ring, 2.5-cm wide and 7.6 cm in diameter, located 9.6 cm from the cathode. The diaphragm is located

on the downstream side of the anode ring. A conical Teflon insert, with a half-angle of about 12.5 degrees reduces the driver volume to 350  $\text{cm}^3$  and provides a fairly smooth internal contour from the cathode tip



to the driven tube. A stainless steel wire, 0.025-cm diameter, is strung across the opening; the trigger pull wire is attached to this wire. In operation, the arc is initiated by pulling the trigger wire toward the cathode.

Mylar diaphragms (0.035 cm thick) are used to reduce losses due to diaphragm opening and to ensure fast operation. Helium or hydrogen gas is supplied to the driver at a pressure of 1.19  $\text{MN/m}^2$  (11.8 atm), just 4 percent less than the static rupture pressure of the diaphragm. When the arc is struck, the trigger wires disintegrate nearly instantaneously; immediately thereafter, the diaphragm disintegrates and leaves an opening which is much larger than when metal diaphragms are used.

The driven tube used for tests with a mixture of 80 percent helium and 20 percent hydrogen (planetary atmospheres) was 11.3 m long. Shock velocities as high

(continued overleaf)

as 45 km/sec have been produced with test times of several microseconds. Attenuation of the shock wave was only 10 percent over a distance of 7 m. Although it has been possible to increase shock velocities by a factor of 2 to 3 by use of the improved shock tube, the performance of the tube suggests that even greater velocities can be obtained with larger energy storage facilities.

**Note:**

Requests for further information may be directed to:

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